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Published in:
Book of Abstracts

Publication date:
2009

Document Version
Publisher's PDF, also known as Version of record

Time-dependent guiding-center transformation

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The purpose of guiding-center coordinate transformation is to remove the fast gyro-motion timescale of a charged particle in a background electromagnetic field. This task has already been accomplished for time-dependent magnetic and electric fields [1]. The guiding-center transformation with time independent electromagnetic fields has been carried out using an easier and more transparent method, namely the method of Lie transform[2]. Here a calculation of second order guiding-center coordinates of a charged particle in a time-dependent strong electrical field is presented applying this method. From a variational principle a Vlasov-Poisson model with a self-consistent local energy theorem is found.

This work is relevant when constructing gyrokinetic and gyrofluid models for the edge/SOL regions of magnetized plasma, where strong radial electric fields are found.

[1] R.G. Littlejohn, Phys Fluids **24**(9), 1730, (1981).
[2] A.J. Brizard, Phys Plasmas **2**(2), 459, (1995).